KEYSPAN ENERGY MANAGEMENT

COMBINED HEAT and POWER WORKSHOP

INSTITUTIONAL CASE STUDY Case Study Overview

- □ Site
- ☐ Installed Capacity
- ☐ Commissioning Date
- ☐ Fuel Input
- ☐ Peak Summer Load
- ☐ Peak Winter Loads
- Minimum Loads
- ☐ Plant Location
- ☐ Electrical Operation
- □ Major Equipment
- ☐ Emission Control
- □ PURPA Qualified

Staten Island University Hospital - So.

1,150 kW / 4.5 MM BTU/hr

January, 1992

15.5 MMBTU/hr

1,200 kW / 20,000 lb./hr

800 kW / 25,000 lb./hr

400 kW / 1,500 lb./hr

Adjacent to boiler room in new building

Grid Parallel; grid Isolated Emergency Mode

CAT G399; CAT G3412 as packaged by

Tecogen, Inc.

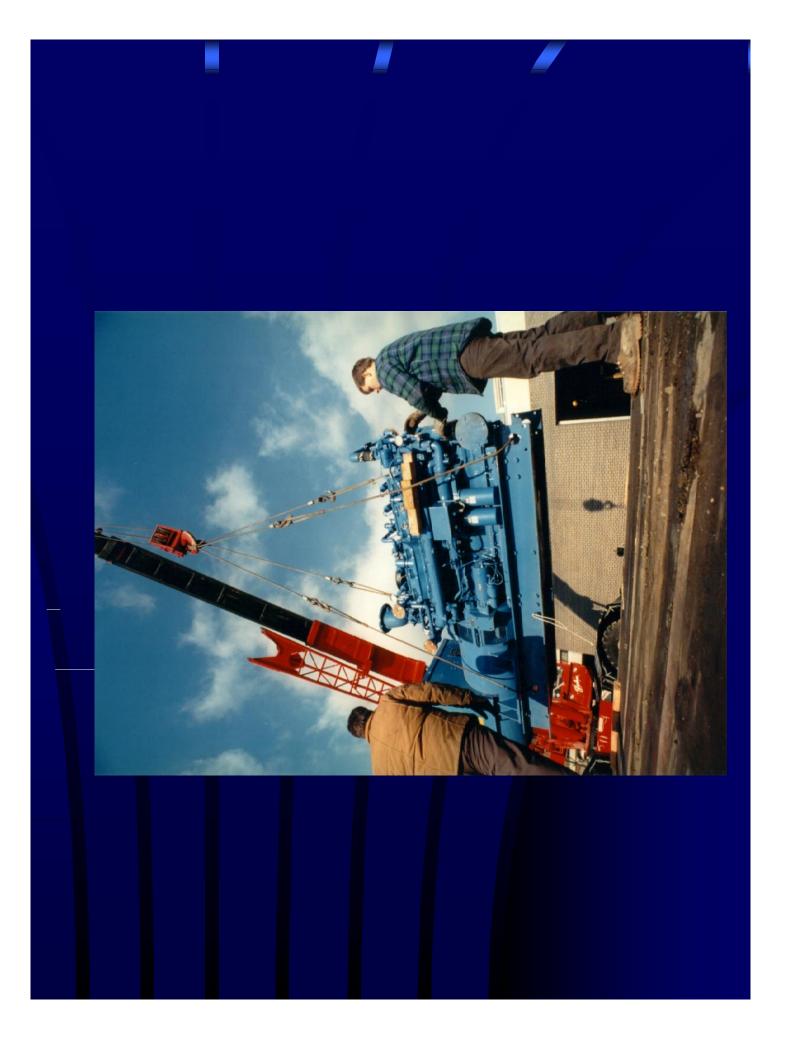
Catalytic Converter (retrofit)

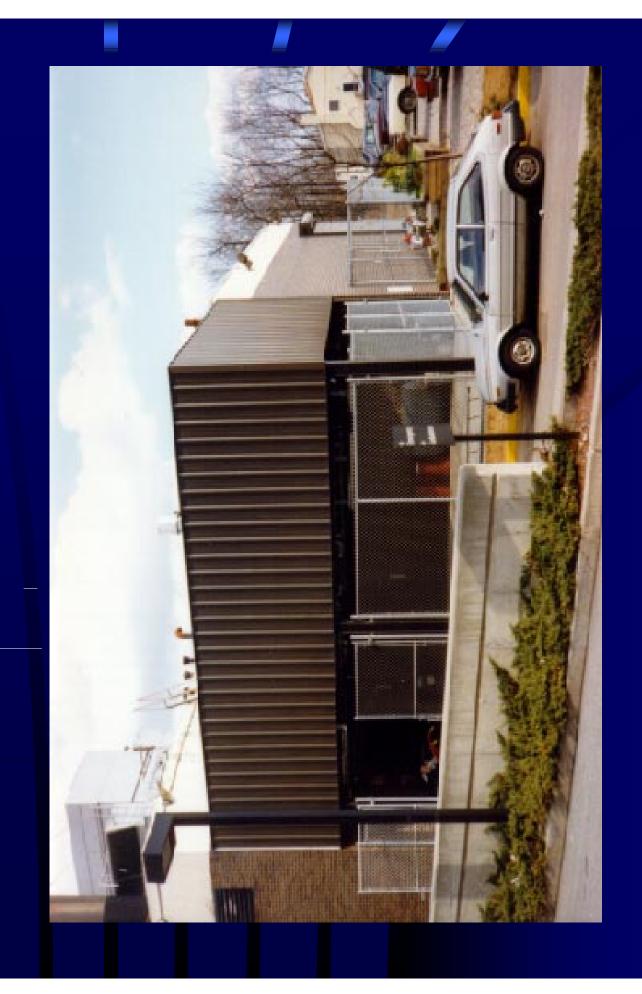
Yes

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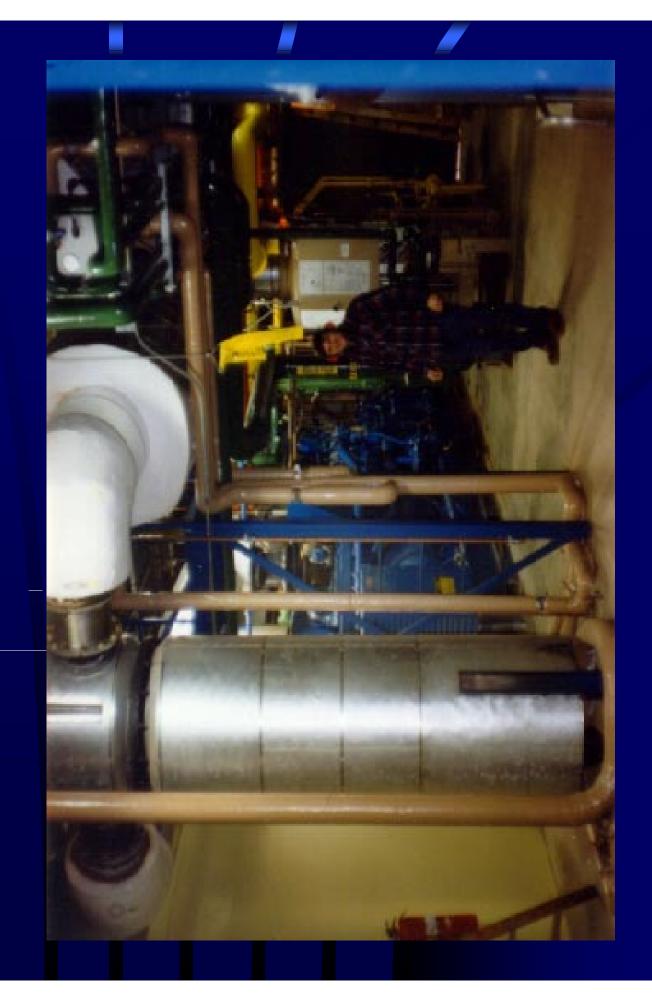














Topics

- ☐ Development process and schedule
- ☐ Fuel Utilization
- ☐ Construction Costs
- ☐ Energy Savings
- □ \$\$\$ Savings
- ☐ Reliability and Availability
- □ Ancillary Benefits
- ☐ Use as emergency generation system (isolated mode)
- ☐ Use for Peak Shaving
- ☐ Parallel Interconnection with grid
- ☐ Constructability and start -up in a Hospital setting
- □ Operations and Maintenance
- ☐ Steam Compression

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Project Participants, Awards

- ☐ Brooklyn Union Gas
- □ NYGAS
- Staten Island University Hospital
- ☐ KeySpan Energy Management
- ☐ 1995 ASHRAE Technology Award
- Staten Island Chamber of Commerce Craftsmanship Award

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Development Process and Schedule

□ DEVELOPMENT CYCLE MUCH LONGER AND MORE EXPENSIVE THAN ANTICIPATED

• Design Iterations, Finance and Cost Iterations, Permits and Approvals

1986 Commence Feasibility

1989 Commence Design and Order Equipment

1990 (Fall) Break Ground

1992 (January) Commission and Acceptance

- 3 to 4 YEAR DEVELOPMENT CYCLE; 18 MONTH CONSTRUCTION
- TIME IS MONEY
- LEGAL EXPENSES AND OTHER SOFT COSTS



Fuel Utilization

- ✓ EXPECTATIONS
- PROJECTED ANNUAL GAS LOAD INCREASE: 70,000 DTH/PER YEAR
- HIGH LOAD FACTOR FIRM GAS PROCURED AT TARIFF RATES
- IMPORTANCE OF FUEL SUPPLY and COST CERTAINTY

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Construction Costs

- ☐ ACTUAL COSTS WERE GREATER THAN ANTICIPATED
 - ☐ Scope Additions
 - □ Unrealistic Preliminary Estimates
- 1st cut estimate (1987)
- Schematic Design Estimate
- Construction Document Estimate

\$1.3 MILLION

\$2.0 MILLION

\$2.4 MILLION

ACTUAL COST

\$2.4 MILLION(APPROX *\$2,000/kW)*

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Energy Savings

DESIGN (PROJECTED) HEAT BALANCE FOR CATERPILLAR G399

	<u>kW</u>	BTU/min	MMBTU/hr	BTU/kW	% TOTAL
Heat Input Total, LHV	2,275	129,379	7.76	11,943	
Heat Input Total, HHV	2,525	143,611	8.62	13,256	
Work Delivered	650	36,963	2.22	3,412	26%
Internal Losses	44	2,502	0.15	231	2%
Exhaust Heat Recoverable	417	23,715	1.42	2,189	17%
Unrecoverable Exhaust Heat	246	13,993	0.84	1,292	10%
Radiation and Convection	91	5,175	0.31	478	4%
Jacket water recovered	668	37,989	2.28	3,507	26%
Aftercooler reject	45	2,559	0.15	236	2%
Oil cooler reject	114	6,483	0.39	598	5%
LHV - HHV Loss	250	14,232	0.85	1,314	10%
TOTAL TOTAL RECOVERABLE	2,252	143,611	8.62	13,256	100% 69%

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Energy Savings (cont')

✓

ACTUAL PERFORMANCE

ANNUAL ENERGY DELIVERY:

Gross Generation

Net Generation

Electric Import

Steam

5,309 MWH (el.) 5,171 MWH (el.) 1,081 MWH (el.) 6,475 MWH (th)

18,115 MMBTU 17,644 MMBTU 3,689 MMBTU 22,094 MMBTU

ANNUAL FUEL CONSUMPTION (PEAK SHAVING FUEL)

UNIT VALUES

Gross Heat Rate
Thermal Recovery

FUEL CHARGEABLE TO POWER
FUEL EFFICIENCY
PURPA EFFICIENCY
"BUBBLE" FUEL SAVINGS

70,392 MMBTU HHV 4,341 MMBTU HHV

13,259 BTU/kWH 4,162 BTU/kWH (13,256 Projected) (5,696 Available)

9,452 BTU/kWH

56.5%

45.2% based on LHV

21.0% (Compared to conventional)

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\$\$\$ Savings

□ Less Than Anticipated

PROJECTED SAVINGS, exclusive of capital recovery

1st YEAR ACTUAL COSTS

FUEL

O&M

1st YEAR SAVINGS IN UTILITY CHARGES

ELECTRIC DEMAND

ENERGY

STEAM RECOVERY

SAVINGS (1st YEAR)

SAVINGS (subsequent years)

REASONS FOR MARGINAL ECONOMICS

Additional expenses (e.g.catalyst retrofit)

Increase in tariff gas costs

Short duration "trips" (less than one hour) results in demand charge

Minimum demand charge

Important electricity greater than anticipated (control issue)

\$228,000

\$375,775

\$286,519

\$ 89,256

\$580,536

\$152,848

\$326,380

\$101,308

\$204,761

\$125,000-\$175,000

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Reliability and Availability

√

Exceeded Expectations

Plant Availability
Main Engine

99.897% 1st 98.482% 1st 99.868% 2nd year 96.42% 2nd year

In the first year

10 Forced outage hours
Successful peak shaving 792 out of 796 hours
1/2 hour is sufficient to incur demand charge

Subsequent years - 90% - 99% Overhauls last one full week

Several trips were more than nuisance (valve swallowed, exhaust pipe problem, retrofit catalyst)

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Use as Emergency Generation System (isolated mode)

- ✓ Met Expectations
- Automatic switch over to isolated mode
- Usually successful if site load < engine capability
- Black start required if site load > engine capability
- Complicated control scheme, technical issues

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Use for Peak Shaving

< 1

Met Expectations

- Second backup engine used in Summer to meet added 400 kW load
- Successful on average 2 out of 4 months in "picking up" demand savings
- Redundancy is lost when peak shaving

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Parallel Interconnection with Grid

- ✓ Successful paralleling, Auto resynch
- Detailed study is required
- Host utility was professional and helpful after project was clearly a GO
- Paralleling Switchgear and Relay Protection meets Utility standards
- Fair interconnect charges were assessed (\$35K)
- Problems with utility distribution system effects parallel connection demand charges should be waived for these instances
- Ancillary benefits must be valued

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Constructability and Start - Up in a Hospital Setting

- ✓ Minimum impact due to green field site
- Outages are required to make critical electrical, steam connections
- Several short duration disruptions during start up
- Control system debug

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Operations, Maintenance and Costs

- ☐ Critical parameters are monitored
- □ Water Treatment is Mandatory (ebullient cooling, HRSG)
- Monthly engine oil changes (at night) necessary
- ☐ Top end overhauls annually
- Balance of plant servicing
 - ☐ Failures include air handling unit bearings, battery charger switcgear breaker, exhaust pipe
 - ☐ Key plant components: Heat Recovery boiler, fluid cooler, air compressor, water treatment, back up engine radiators, motor control center, pumps, controls, emission control, ventilation system, switchgear
- ☐ Major overhauls 30,000 hours
- □ Average unit O&M costs: 1.6 to 2.4 cents per kWH
- ☐ Hidden costs: Additional time required of operators
- Operators are important : semi attended operation is necessary

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CONCLUSIONS

- ☐ Plant is reliable, not perfect
- □ Costs (construction and operating) are greater than anticipated
- Development cycle is longer than anticipated
- ☐ Savings alone would not justify this project
- ☐ Fair value for ancillary benefits would enhance economics and justify this plant class
- □ Usefulness as emergency generation system was proven : reliable, but not perfect
- ☐ Back up tariffs should be fair and market based
- ☐ Economics, not PURPAnomics, should influence this market
- Long Term Planning and Thinking is essential

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